IN THE DRAWINGS:

A replacement sheet for Figure 4 labeled "Replacement Sheet" is submitted herewith, in which the output of the closed loop controller 32 is connected to the current driver 44; a line is inserted between "PC" and "Memory" between blocks 42 and 40; and references designations for resistors R3 and R4 have been reversed to further clarify that which the Applicants regard as the invention in response to objections to the specification and drawings, and in accordance with informal drawings filed with the application.

REMARKS

The non-final Office Action mailed October 4, 2004 and the references cited therein have been carefully considered. The specification, Figure 4, and Claims 1 and 14 have been amended, and new Claims 24-32 have been added in a sincere effort to further clarify that which the Applicants regard as the invention.

Support for this Amendment is found generally within the specification, claims, and drawings, as originally filed. Specifically, support for the amendments to Claims 1 and 14 is provided at page 9, line 22 through page 10, line 6; and page 11, line 28 through page 12, line 27. Support for new Claims 24-32 is provided at page 5, line 25 through page 7, line 13, page 9, line 22 through page 11, line 3; and page 12, lines 4-17. As a result of this Amendment, taken together with the remarks set forth below, it is respectfully submitted that pending Claims 1-32 are now before the Examiner in condition for favorable consideration and allowance.

The specification and drawings have been objected to due to various informalities. Accordingly, the specification has been amended to indicate that resistor R5 is not shown in Figure 2 (page 7, line 10) and to exchange references to resistors R3 and R4 (page 10, lines 17-19) in accordance with Figure 4. Similarly, a replacement sheet for Figure 4 is submitted herewith, in which the closed loop controller 34 is connected to the current driver 44, a line is drawn between "PC" and "Memory" between blocks 42 and 40, and reference designations for resistors R3 and R4 have been reversed. Therefore, it is respectfully submitted that the objections to the specification and drawings have been obviated.

Claims 1, 2, 7-10, 12-15, 18-20, 22, and 23 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,343,514 to Smith (*Smith*). Specifically, the Office Action indicates that *Smith* teaches a flow sensor comprising a flexible membrane 104 and a plurality of sensors operatively connected to the membrane, wherein at least one sensor 42 detects the ambient temperature, at least one sensor 41 detects the pressure, and at least one sensor detects the flow.

Claims 1-4, 7-10, 12-16, 18-20, 22, and 23 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,259,248 to Ugai et al. (*Ugai*). The Office Action states that *Ugai* teaches a multi-sensor including a flexible membrane 9 and a plurality of sensors 1-8, 30 for detecting ambient temperature, pressure, and flow.

Claims 5-7, 11, 17, and 21 were rejected under 35 U.S.C. §103(a) as being unpatentable over *Ugai* in view of U.S. Patent No. 5,393,351 to Kinnard et al. *(Kinnard)*. Specifically, the Office Action indicates that *Ugai* teaches each of the features of the claimed invention, except for a silicon dioxide isolation layer between the sensors and the membrane, and the flow rate sensor being a constant-temperature anemometer. However, it is stated that *Kinnard* teaches a thermal anemometric device and a plurality of isolation layers between the sensors of the membrane, and that it would have been obvious to provide these layers for higher thermal efficiency, lower dielectric loss, and higher mechanical stability.

The present invention is directed to a flow sensor, which includes a flexible membrane and a plurality of sensors. The plurality of sensors is positioned on the flexible membrane. At least one of the plurality of sensors is adapted for detecting ambient temperature, at least one of the plurality of sensors is adapted for detecting pressure of a medium, and at least one of the plurality of sensors is specifically adapted for sensing a flow rate of the medium independent of detecting ambient temperature and pressure, as now defined by amended Claim 1.

The present invention is also directed to a method of sensing a flow rate of a medium, which includes providing a flexible membrane, positioning a plurality of sensors on the flexible membrane, and detecting ambient temperature by at least one of the plurality of sensors. The method further includes detecting pressure of a medium by at least one of the plurality of sensors, and sensing a flow rate of the medium by at least one of the plurality of sensors specifically adapted for sensing the flow rate of the medium independent of detecting ambient temperature and pressure, as now defined by amended Claim 14.

Smith relates to a device for measuring only pressure and temperature, which are then used to calculate the flow, as described at column 5, lines 8-9. The device includes a sensor 6 having a sensor support body 13 and a diaphragm 15, which covers a cavity 14 formed in the support body 13. A pressure sensor 41 is mounted on the diaphragm, and a temperature sensor 42 is mounted in the vicinity of the pressure sensor.

As shown in Figure 4 and described at column 4, lines 34-48, only the sensors used to measure pressure and temperature are located on the diaphragm. In addition, there is no sensor that is specifically adapted for sensing the flow rate of the medium independent of detecting ambient temperature and pressure, as now defined by amended Claims 1 and 14. The flow sensor may be implemented as a constant temperature anemometer, as defined by Claims 11 and 21.

Further, nothing in *Smith* would teach or suggest coupling at least four resistors positioned on the flexible membrane in a Wheatstone bridge configuration, as now defined by Claim 32. Positioning these resistors on the flexible membrane significantly improves the sensitivity and reliability of pressure, temperature, and flow measurements, while simplifying the overall design. In addition, *Smith* does not disclose how to incorporate a constant temperature anemometer in a Wheatstone bridge configuration to measure the flow rate, as described at page 11, line 28 through page 13, line 6.

The advantages of using at least four resistors in the Wheatstone bridge configuration include higher sensitivity, as well as improved compensation for lateral forces and temperature. As described in *Elektrisches Messen Nichtelektrischer Grössen mit Halbleiterwiderständen (Electrical Measurement of Non-electrical Characteristics with Semiconducting Resistors)*, Verlag Technik, Berlin, pp. 47-48 (1971) a copy of which is submitted herewith, the sensitivity of a half bridge configuration (equation 4.14) in which there are only two active resistors, is only half that of a full Wheatstone bridge configuration (equation 4.13). Similarly, sensitivity of a quarter bridge configuration (equation 4.15) in which there is only one active resistor, is only a quarter of that of the full Wheatstone bridge configuration (equation 4.13).

Claims 8, 18, and 32 require the use of at least four resistors in a Wheatstone bridge configuration, which results in the greatest sensitivity. Specifically, as described by Figure 1, resistors R1 and R4 are positioned at the edge of the diaphragm, which provides the highest radial strain, and thus sensitivity. Resistors R1 and R4 are subjected to negative radial stress and a small tangential stress, as described in Figure 11-39 of C. C. Perry and H. R. Lissner, *The Strain Gage Primer*, McGraw-Hill, pp. 228-229 (1955) a copy of which is submitted herewith. The tangential stress at resistors R1 and R4 is substantially zero, and thus has no significant influence on the measurement result. Further, the cross-sensitivity of the resistors is very small, that is, the sensitivity of resistors R1 and R4 is low in the radial direction, but high in the tangential direction; having a ratio of about 1:100.

Likewise, resistors R2 and R3 are positioned in the center of the flexible membrane, which provides the greatest tangential strain, and thus sensitivity. Resistors R2 and R3 are subjected to a positive tangential stress and a positive radial stress, as described by Figure 11-39 of *The Strain Gage Primer*. Although both stresses are of substantially the same value, and compensation through placement on the flexible membrane is difficult, the cross-sensitivity of the resistors is advantageously very low. That is, the sensitivity of resistors R2 and R3 is high in the tangential direction, but low in the radial direction; having a ratio of about 1:100. Thus, the present invention advantageously provides the greatest possible sensitivity while maintaining excellent temperature compensation by subjecting each of the resistors to the same temperature change on the flexible membrane.

Ugai relates to an integrated composite sensor shown in Figure 1, which is used in a differential pressure transmitter for detecting pressure in a chemical plant. As described at column 7, lines 21-44, Figure 5A shows a top view of a multi-sensor, in which differential pressure detecting gage resistors 1-4 are formed in the area of a diaphragm 9 by doping a semiconductor substrate 10. Static pressure detecting gages resistors 5-8 are positioned around the differential pressure detecting resistors 1-4, and resistors 6 and 7 are formed on static pressure detecting diaphragms 12a, 12b. However, a temperature gauge resistor 30 is located on a fixed portion, as described at column 7, lines 41-42 and column 8, lines 39-43,

which is not on the diaphragm. Thus, nothing in *Ugai* would teach or suggest locating the ambient temperature sensor on the diaphragm, and there is no sensor disclosed that is specifically adapted for sensing the flow rate of a medium independent of detecting ambient temperature and pressure, as now defined by amended Claims 1 and 14.

Further, as described at column 1, lines 36-47, *Ugai* utilizes a differential pressure measurement technique, rather than the constant temperature anemometer defined by Claims 11 and 21. The *Ugai* technique clearly requires measurement of the difference in pressure at two points as shown in Figure 2 and described at column 4, line 66 through column 5, line 43. This technique has several disadvantages including changing the flow pattern, and thus influencing its measurement; unreliable readings for low pressure and dynamic flow measurements; increased cost due to the requirement of additional equipment; and unsuitability for directional flow measurements.

Kinnard relates to multilayer, thin-film thermal converters that are suitable for use as calibration standards and the measurement of AC and RF voltage and current. However, it is unclear where *Kinnard* refers to silicon dioxide isolation layers and the concept of a constant temperature anemometer, as indicated in the Office Action. Further, nothing in *Kinnard* would teach or suggest sensors for detecting or sensing pressure, temperature, and flow positioned on a flexible membrane, or that one of these sensors is specifically adapted for sensing the flow rate of a medium independent of detecting ambient temperature and pressure, as now defined by amended Claims 1 and 14. In addition, the thermocouple element and Peltier element utilized in *Kinnard* are well known, but have several disadvantages that have made them substantially obsolete, such as reduced sensitivity to low pressure and flow rates, and insufficient sensitivity to dynamic flow rates.

Applicants respectfully note that in order to support a claim of *prima facie* anticipation, a single reference must teach or enable each of the claimed elements as arranged in the claim interpreted by one of ordinary skill in the art. Further, in order to support a claim of *prima facie* obviousness, the cited references must teach or suggest each and every

element of the invention, and there must be a motivation in the references or the prior art to combine the references and the prior art as suggested.

However, nothing in the art of record, which includes U.S. Patent Nos. 5,503,034 to Amano et al.; 6,542,761 to Jahn et al.; and 6,625,029 to Bernini, would teach or suggest, either alone or in combination, a flow sensor including a plurality of sensors positioned on a flexible membrane, wherein at least one of the sensors is adapted for detecting ambient temperature, at least one of the sensors is adapted for detecting pressure, and at least one of the sensors is specifically adapted for sensing a flow rate of the medium independent of detecting ambient temperature and pressure, as now defined by amended Claim 1. In addition, nothing in the art of record would teach or suggest a method of sensing a flow rate of a medium including providing a flexible membrane, positioning a plurality of sensors on the flexible membrane, detecting ambient temperature by at least one of the sensors, detecting pressure by at least one of the sensors, and sensing flow rate by at least one of the sensors specifically adapted for sensing the flow rate of the medium independent of detecting ambient temperature and pressure, as now defined by amended Claim 14.

Applicants respectfully submit that Claims 2-13 and 24-27, which ultimately depend from Claim 1, and Claims 15-23 and 28-31, which ultimately depend from Claim 14, are patentable over the art of record by virtue of their dependency from Claims 1 and 14, respectively. Further, Applicants submit that Claims 2-13, 24-27, 15-23, and 28-31 define additional patentable subject matter in their own right. Therefore, it is respectfully requested that the rejection of Claims 1-4, 7-10, 12-16, 18-20, 22, and 23 under 35 U.S.C. §102(b) and the rejection of Claims 5-7, 11, 17, and 21 under 35 U.S.C. §103(a) be reconsidered and withdrawn.

In view of the foregoing Amendment and remarks, entry of new Claims 24-32 and the amendments to Claims 1 and 14; favorable consideration of new Claims 24-32 and Claims 1 and 14, as amended; favorable reconsideration of Claims 2-13, 15, and 16-23; and allowance of pending Claims 1-32 are respectfully and earnestly solicited.

Respectfully submitted,

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